SEMESTER I

Paper I
MBCR4101

Part A: Introduction to Biotechnology (40 marks)

Unit I: Biotechnology – a historical perspective (4 lectures)
Unit II: Cellular foundations of biochemistry - The cell theory (4 lectures)
Unit III: Chemical and physical foundations of biochemistry (4 lectures)
Unit IV: Origin and evolution of life: concept of Oparin, Miller's experiment, the first cell, RNA world, prokaryotes, eukaryotes, origin of multicellular organisms, endosymbiosis, the evolution of metabolism, the genetics of life, animal and plant cells and tissues. (10 lectures)
Unit V: Experimental models in biology. (2 lectures)

Teachers involved:
Dr. C. Barat (Units I, II, III)
Dr. A. Banerji (Units IV, V)

Recommended texts:
1) The Cell – A Molecular Approach. G.M. Cooper, R.E. Hausman (5^{th} ed.) Chapters 1 (Unit IV, V), 2 (Unit IV).
2) Lehninger Principles of Biochemistry. M.M. Cox, D.L. Nelson (5^{th} ed.). Chapter 1 (Unit I-IV).

Part B: Biological Macromolecules I (60 marks)

Unit I: Amino acids and peptides: Structure of amino acids, Chemical reactions and modification, physical properties, sequencing, synthesis of peptides. Proteins: End group analysis, Sequencing, Purification. (18 lectures)
Unit II: Nucleic acids: DNA, RNA - basic structure (nucleosides and nucleotides); double helical structure of DNA (Watson-Crick model) - sugar puckering and base stacking; B-, A- and Z-DNA; denaturation and renaturation kinetics of DNA - Cot curve; nucleic acid hybridization and its application; non-enzymatic transformations of DNA; principles of sequencing and synthesis of oligonucleotides; nucleotides with special functions; RNA - folding of RNA into higher order structures; types of RNAs - mRNA, tRNA, rRNA in ribosome; modified nucleotides in tRNA and their importance. (12 lectures)
Unit III: Lipids: Classification, Structure-function, role in biological membranes. Lipoproteins. (6 lectures)
Unit IV: Carbohydrates: Biologically significant monosaccharides, disaccharides, polysaccharides, glycoproteins and proteoglycans – nomenclature; structure; stereochemistry – Fischer projection, Haworth perspective, boat and chair conformation; mutarotation; reactions – oxidation-reduction, esterification, glycoside formation; derivative sugars; polysaccharides – higher order structures; determination of composition; lectins. (10 lectures)

Teachers involved:
Dr. C. Barat (Units I, III)
Dr. U. Siddhanta (Unit II)

Dr. J. Dasgupta (Unit IV)

Recommended texts:
Amino acids and peptides, Lipids:
Biochemistry Voet and Voet (3rd ed.).
Lehninger Principles of Biochemistry. Cox & Nelson (5th ed.).
Nucleic acids: Lehninger Principles of Biochemistry. Cox & Nelson (5th ed.). Chapter 8
Carbohydrates: Biochemistry by Lubert Stryer (6th edition). Chapter 11

Paper II

MBCR4102
Cell Biology I (50 marks)

Unit I: Cell wall: Prokaryotic peptidoglycan, Plant cell wall (5 lectures)
Unit II: Cell membrane: Membrane structure; Membrane constituents, phospholipids, glycolipids, cholesterol, membrane proteins, receptors and phospholipases, phospholipid bilayer, structure asymmetry, fluid mosaic model of random diffusion of membrane components; Domains in membrane, natural and artificial membranes. (7 lectures)
Unit III: Compartmentalization of cells: Endoplasmic reticulum and ribosomes, Golgi bodies, vescicular traffic in the secretory and the endocytic pathway, plastids, chloroplast and mitochondria, lysosomes, peroxisomes, microbodies, Nucleus: Difference between the eukaryotic and prokaryotic genome, Structure of eukaryotic chromosome (nuclear membrane, nucleoplasm, nucleolus, chromatin organization). (7 lectures)
Unit IV: Cytoskeleton: a) Microtubules: structure and polymerization dynamics, microtubule motors, role of microtubules in separation of mitotic chromosomes, movements of cilia and flagella, microtubule dependent drugs b) Actin: structure and polymerization dynamics, actinomyosin complexes and role in muscle contraction, role of actin in cell crawling, actin targeted drugs c) Intermediate filaments. (7 lectures)
Unit V: Cell-cell junctions: structure and functions of tight junctions, anchoring junctions and gap junctions; component proteins; adherens junctions, desmosomes and hemidesmosomes, plasmodesmata; cadherin and types; catenins and selectins (2 lectures)
Unit VI: Extracellular matrix: functions; macromolecular organization: glycosaminoglycan, hyaluronan, proteoglycan and types, collagen and types, fibril-associated collagen, type IV collagen, elastin, fibronectin, basal laminae and laminin (3 lectures)
Unit VII: Overview of the cell cycle: a) Mitosis and cytokinesis b) Meiosis: stages, Meiosis I and Meiosis II, synapsis, synaptonemal complex, crossing over and chiasma, terminalisation (5 lectures)

Teachers involved:
Dr. C. Barat (Units II, III, IV)
Dr. A. Roy Choudhury (Units I, V, VI, VII)

Recommended texts:
Cell Wall (Prokaryotic peptidoglycan) – Prescott's Microbiology (8th Edition) –Chapter 3
Plant Cell Wall – Plant Physiology Taiz and Zeiger (4th Edition) – Chapter 15

Mitosis and Meiosis: Cell and Molecular Biology – P. Sheeler, D.E. Bianchi (3rd Edition) – Chapter 20
Membrane Structure: Cell and Molecular Biology Gerald Karp (4th Edition)
Molecular Biology of the Cell Bruce Alberts et. al (5th edition)
Compartmentalization: 1) Lehninger 2) The Cell – A Molecular Approach – G.M. Cooper, R.E. Hausman
Cell-cell junctions: Bruce Alberts (4th Edition) Chapter 19
Extracellular Matrix: Bruce Alberts (4th Edition) Chapter 19

MBCR4152

Analytical Biochemistry Practical I (50 marks)

Unit I: Preparation of buffers and pH determination.
Unit II: Determination of buffering action of amino acids by titration.
Unit III: Estimation of total quantity of amino nitrogen (Sorensen's formol titration method).
Unit IV: Analytical detection of proteins (albumin, gelatin, peptone), carbohydrates (glucose, fructose, sucrose, lactose, starch), lipids and nucleic acids (DNA, RNA).
Unit V: Spectrophotometric quantitation of protein (Lowry, biuret) and preparation of standard curves.
Unit VI: Spectrophotometric quantitation of DNA (diphenylamine method).

Teachers involved:
Dr. S. Saha
Dr. A. Banerji

Paper III

MBCR4103

Microbiology I (50 marks)

Unit I: History of Microbiology: Microbiology - the subject; concept of prokaryotes and eukaryotes; concept of microorganisms (prokaryotic microbes and eukaryotic microbes); Microscopy and the discovery of microorganisms; contribution of Anton van Leeuwenhoek; Theory of Spontaneous Generation (Abiogenesis); Theory of Biogenesis; contributions of Louis Pasteur and Robert Koch (including Koch's Postulates) in the development of Microbiology; Discovery of viruses; Microbiology Today - an era of Molecular Microbiology. **(6 lectures)**

Unit II: Microscopy: Units of measurement; Idea of Microscopes and Microscopy; concept of magnification / magnifying power (including Empty Magnification), resolving power / resolution, numerical aperture, limit of resolution; types of objective lenses; use of oil- immersion objective lens; classification of microscopes; principle of operation and applications of conventional light microscopes (bright-field, dark-field, fluorescence and phase-contrast microscopes) and electron microscopes (TEM, SEM and STEM); Electron Cryotomography / Cryo-electron tomography; brief idea of advanced microscopes (SPM including AFM / SFM and STM, CSLM, DICM / NIC).
(8 lectures)

Unit III: Stains and Staining Techniques: Need of staining; detailed concept of chromophore, auxochrome, and chromogen; detailed concept of dyes and stains; ionic basis of staining; staining solutions; concept of smear and its preparation; fixation and its types; mordant and its function; detailed classification of staining procedures; details of simple / monochrome staining and differential staining; Gram-staining – a detailed account. **(4 lectures)**

Unit IV: Bacterial growth: Definition of bacterial growth; detailed account of growth / reproductive strategies in bacterial cells (including binary fission); details of bacterial cell cycle (including chromosome replication and partitioning – MreB model and cytokinesis – Z ring and Divisome complex); detailed description of different phases of monoauxic bacterial growth; mathematics of exponential bacterial growth; basic concepts of batch, continuous and synchronous cultures; influences of environmental factors on bacterial growth; microbial growth in natural environments (including Liebig's Law of the Minimum, Shelford's Law of Tolerance and Quorum sensing); different methods of measurement of bacterial growth. **(6 lectures)**

Unit V: Bacterial Nutrition: Definition of bacterial nutrition; detailed account of the nutritional classification of bacteria (autotrophs, heterotrophs; phototrophs, chemotrophs; lithotrophs – photolithotrophs and chemolithotrophs, and, organotrophs – photoorganotrophs and chemoorganotrophs); effect of oxygen on bacterial growth – classification of bacteria depending on their oxygen requirement and tolerance, toxic forms of oxygen and their scavenging; nutrients for bacteria - macronutrients, micronutrients / trace-elements and growth factors; special nutritional requirements; nutritional flexibility in heterotrophs / omnivory; fastidious bacteria**.** **(4 lectures)**

Unit VI: Controlling Microbial Growth in the Environment and in the Body: Definition, application and examples of some frequently-used terms (sterilization, sterilant, decontamination, disinfection, disinfectant, sanitization, sanitizer, antisepsis, antiseptic, biocide – including microbicidal and microbistatic agents, germicide, and chemotherapy); details of physical antimicrobial control (heat, low temperatures, filtration and radiation); details of chemical antimicrobial control, including chemical antimicrobial agents for external use (phenol and phenolics, alcohol, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases), and, antibacterial agents used *in vivo* / antimicrobial chemotherapeutics (natural / antibiotics, semisynthetic and synthetic agents; bacteriostatic, bactericidal and bacteriolytic agents; concepts of MIC and MBC / MLC; measuring antimicrobial activity by dilution susceptibility technique, disk-diffusion technique / Kirby-Bauer method and E-test; selective toxicity and chemotherapeutic index / CTI; narrow-spectrum and broad-spectrum agents); biological antimicrobial control (including predation of one microorganism on another, viral-mediated lysis, and toxin-mediated killing). **(6 lectures)**

Teacher involved:
Prof. S. Roy

Recommended texts:

1) Brock Biology of Microorganisms – Madigan, Martinko, Dunlap and Clark (12^{th} Edition) - Chapters 1, 2, 5, 6, 27.

2) Prescott's Microbiology-Willey, Sherwood and Woolverton (8^{th} Edition) - Chapters 1, 2, 6, 7, 8.

3) Fundamental Principles of Bacteriology – Salle (7^{th} Edition) (Reference) - Chapters 2, 3, 7, 8, 16.

Paper III

MBCR4153

Microbiology Practical I (50 marks)

Unit I: Introduction to common Laboratory Instruments and Equipments, and basic ideas of Sterility maintenance: Principle of operation of Autoclave, Hot-Air Oven, Laminar Air-Flow cabinet, Incubator, BOD-Incubator-Shaker; uses of other common laboratory equipments; maintenance of sterility in a Microbiology laboratory.

Unit II: Operation of a compound light microscope: Different mechanical and optical parts of a microscope, and their functions; use of oil-immersion objective lens; observation and identification of pre-stained permanent slides of different microorganisms.

Unit III: Preparation of culture-media: Concept of different types of culture media (according to composition and function) for microorganisms; preparation of liquid (broth) and solid (agar) media.

Unit IV: Cultivation of microorganisms in pure culture:

a. Cultivation of microorganisms as a pure culture in broth and agar (slant, stab).
b. Spread-plate, pour-plate and streak-plate methods of isolation of pure cultures.

Unit V: Preservation of pure cultures: By serial-subculture and refrigeration.

Unit VI: Staining techniques of microorganisms:

a. Simple staining of bacteria: *Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Klebsiella aerogenes.*
b. Gram staining of bacteria: *Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Klebsiella aerogenes.*
c. Fungal staining: i.) Yeast: *Saccharomyces cerevisiae;* ii.) Molds: *Penicillium chrysogenum, Aspergillus niger.*

Unit VII: Microbiological assay of antibiotics (using suitable test bacteria):

a. Antibiotic sensitivity test by paper-disc (Kirby-Bauer) method;
b. Determination of Minimal Inhibitory Concentration (MIC) by serial dilution method.

Teachers involved:
Prof. S. Roy
Dr. D. Chakraborti

Recommended texts:

1) Microbiology: A Laboratory Manual - Cappuccino and Sherman.
2) Experiments in Microbiology, Plant Pathology and Biotechnology – K. R. Aneja.
3) Practical Microbiology – R. C. Dubey.

Paper IV

Physics I (Composite Paper)

PH21012 T (70 marks)

PAPER 1: Module A: Math. Methods, Mechanics and General properties of matter (24 lectures)

Math. Methods: **(**5 lectures)

Vectors, Dot and cross products, scalar triple product, vector triple product. Scalar and vector fields - gradient, divergence and curl. Statements of Stoke's and Divergence theorem, polar coordinates.

Mechanics: **(**7 lectures)

Newton's laws of motion, principles of conservation of linear momentum, time and path integral of forces, Central forces, conservative force field (few examples), concept of potential, conservation of total energy

Rotational kinematics and dynamics - equations of rotational motion, kinetic energy of a rotating body, conservation of angular momentum.

Moment of inertia - its physical significance, radius of gyration, parallel and perpendicular axes theorem. Problems involving rotational dynamics.

Properties of matter: **(**4 lectures)

Elasticity - Stress, strain, Hooke's law, different types of moduli of elasticity for isotropic homogeneous bodies, interrelations of elastic moduli (no derivation), torsion of a cylinder, internal bending moment, bending of beam supported at ends with a concentrated load at the centre.

Surface Tension: **(**4 lectures)

Surface tension forces, relation between surface tension and surface energy, molecular theory (property of surface layer), angle of contact, expression for the excess pressure over a curved surface (without deduction), capillarity, Jurin's law, factors affecting surface tension of a liquid(qualitative).

Dynamics of fluids: **(**4 lectures)

Streamline and turbulent motion, equation of continuity, coefficient of viscosity, critical velocity, Reynold's number, Poiseuille's equation, Stokes law (statement only), terminal velocity, Bernoulli's theorem and applications.

Module B: Vibration, Waves and Optics (24 lectures)

Vibrations and Waves: (10 lectures)

Simple harmonic motion - Superposition of simple harmonic motion, analytical treatment, Lissajous figures,

analytical solution for natural, damped and forced vibration, resonance, sharpness of resonance.

Differential equation of wave motion - plane progressive wave, energy and intensity of plane wave.

Superposition of waves - stationary waves, beats, speed of transverse vibrations in stretched strings. Doppler effect.

Optics: **(**14 lectures)

Fermat's principle and its application to reflection and refraction in plane surfaces. optical systems. Refraction of light at curved surface, Lens-maker's formula in paraxial approximation, combination of thin lenses, equivalent focal length.

Dispersion and dispersive power. Dispersive power of prisms.

Light as electromagnetic wave, Statement of Huygen's principle, Validation of the principle in case of reflection.

Interference - Concept of spatial and temporal coherence, Young's Double slit experiment, intensity distribution, shapes of fringes and fringe width, Newton's ring.
Diffraction - Fresnel and Fraunhofer class. Fraunhofer diffraction, Single slit diffraction, plane transmission grating. Resolving power , Rayleigh's criterion, resolving power of telescope and diffraction grating (Qualitative).
Polarisation - States of polarization, Brewster's law, Polaroid.
Laser: Stimulated emission and absorption, Einstein coefficient, Population inversion, Block diagram and principle of operation of a ruby laser.

Recommended texts:

Handbook of Degree Physic. C.R. Dasgupta, Volumes 1 and 2.

PH21012 P (30 marks)

Module C: Gen. Lab. I

1. Determination of the modulus of rigidity of the material of a given wire by dynamical method.
2. Determination of the moment of inertia of a cylinder about an axis passing through its centre of gravity and perpendicular to its length using a cylinder as an auxillary body and comparison of the moment of inertia thus obtained with the theoretical value calculated with the measured mass and dimensions of the bar.
3. Determination of the refractive index of a liquid and that of the material of the convex lens by using the lens and a plane mirror.
4. Determination of the surface tension of water by capillary rise method.
5. Determination of the Young's modulus of the material of the given uniform bar supported at two ends and
loaded at the centre.
6. Calibration of a given polarimeter and determination of the concentration of an unknown sugar solution.

Paper V

MBCH4105

Chemistry I (50 marks)

Unit I: Elementary Quantum Mechanics: Concept of electromagnetic radiations, Idea of wave particle duality, de Broglie hypothesis, Heisenberg's Uncertainty Principle, Schrodinger equation (time independent), Elementary concepts of operator, Eigen function and Eigen values, Schrodinger's equation, Particle in one dimensional box (time independent), Rydberg constant, Concept of orbitals and shapes of s, p, d orbitals. (10 lectures)

Unit II: Acid-base Concept and Ionic Equilibrium in Aqueous Solution: Arrhenius concept, Theory of solvent system, Bronsted and Lowry's concept, Relative strength of acids, Lux-Flood definition, Lewis concept, HSAB principle, Solvent properties of water and liquid ammonia, Ionization of water, Ionic product of water, pH, Buffer solutions, pH of buffer solutions, Henderson equation, Buffer capacity, Hydrolysis of salt, pH of salt solution, Buffer solution in biological systems, Polyprotic acids, Acid-base neutralization curves, Acid-base indicators, Choice of indicators, Solubility product principle, common ion effect and their applications in the separation and identification of common cations. (10 lectures)

Unit III: Stereochemistry: Representation of molecules in Fischer, Flying-wedge, Sawhorse and Newman formulae and their intertranslations; Chirality; Elements of symmetry- rotational axis of symmetry, plane of symmetry, center of symmetry and alternating axis of symmetery; Asymmetry and Dissymmetry; Enatiomerism and diastereomerism; Optical activity; Specific rotation; Racemization; Optical purity; Stereogenic centres; Isomerism involving like/unlike chiral centres; Chirotopicity and achirotopicity; D/L, R/S, E/Z, syn/anti, cis/trans, meso/dl, threo/erythro nomenclature; Conformational nomenclature- dihedral angle, eclipsed/staggered and gauche/anti, energy barrier of rotation, relative stability of conformers on the basis of steric effect, dipole- dipole interactions, H-bonding; Conformational analysis of ethane, propane, n-butane, 2-methylbutane; Conformational analysis of cyclohexanes- chair and boat conformations, conformational analysis of mono- and di-substituted cyclohexanes. (14 lectures)

Teachers involved:
Dr. J Dasgupta (Unit I)
Dr. S. Saha (Units II, III)

Recommended texts:
1) Unit I: Physical Chemistry with the application to Life Sciences by Eisenberg and Crothers. Chapter: 10
2) Unit II: General and Inorganic Chemistry (Part-I). R. P. Sarkar (3^{rd} Edition), Chapter 10, 11
3) Unit III: Basic Stereochemistry of Organic Molecules. Subrata Sengupta (3^{rd} Edition), Chapter 1-3, 5, 6

MBBM4105
Mathematics I (50 marks)

Elements of Algebra
Unit I: Theory of Equations; Polynomials, Descartes's rule of signs, extraction of roots of quadratic, cubic and biquadratic equations, Relation between roots and coefficients, Transformation. Simple problems only. (10 lectures)
Unit II: Matrix Theory: Matrix Operations, Symmetric and skew –symmetric matrices, orthogonal matrix, Determinants, Application to solution of system of equations, Cramer's rule, Eigen values and eigen vectors, Diagonalization of matrices, Quadratic form. (18 lectures)
Unit III: Set Theory: Sets and set operations, Relations, Functions, Injective, surjective and bijective functions, inverse of a function, composition of functions, Cardinality of a set, Cardinality theorem, Cartesian product of sets. (8 lectures)

Teachers involved:
Ms. S. Ray

Recommended texts:
1) Higher Algebra by S. K. Mapa [Part I : Chapter 1; Part II: Chapter 1,2,34 (Exercises:9,12,13,14)]
2) Classical Algebra by S. K. Mapa [Complex Number and Theory of equation]